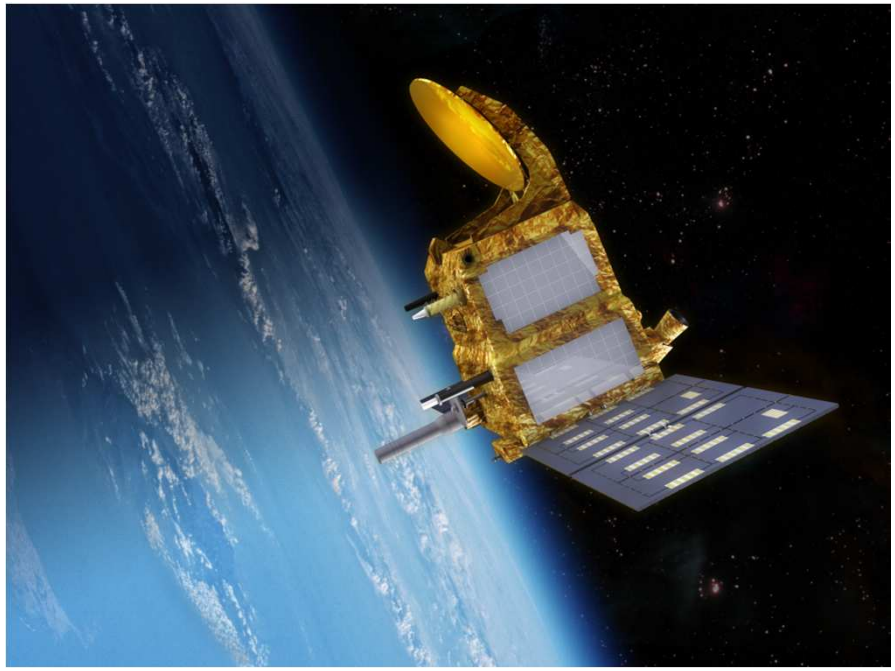
ALTIKA : FIRST RESULTS



Nathalie STEUNOU

and the SARAL/AltiKa teams

SUMMARY

1. Introduction
2. Data availability
3. Estimated performances
4. Sigma0 and attenuation in Ka-band : some preliminary results
5. Outlook for SWOT

Introduction : SARAL program

SARAL Program is a joint mission conducted by ISRO and CNES dedicated to environmental, mainly oceanic, monitoring.

Two missions are on-board the SARAL satellite **ALTIKa mission and ARGOS-3 mission**

SARAL ⇔ Satellite with ARgos and Altika : *also means "simple" in Hindi*

Scientific objectives of the ALTIKA mission

- Ocean meso-scale variability study with an improvement in vertical and spatial measurement resolution thanks to Ka-band altimeter
- Providing geophysical data assimilation in a global ocean model
- contribution to :
  - coastal altimetry, continental waters and inland ice sheet monitoring, light rainfall and clouds climatology,
  - Geodetic reference system determination thanks to Doris and LRA

SARAL orbit

Same orbit/ground-track as ENVISAT, complementary to Jason2/JASON3 ground-track

A few milestones

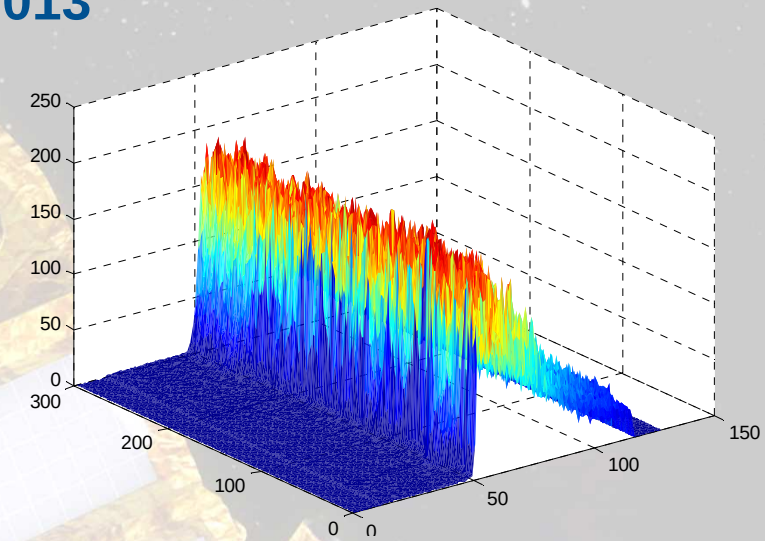
- First studies and altimeter phase 0/A : 1998
- 1st semester 2005 : first discussions between CNES and ISRO
- February 25th, 2013 at 12:31 UTC : Take-Off !! from SHAR

AltiKa : a new concept

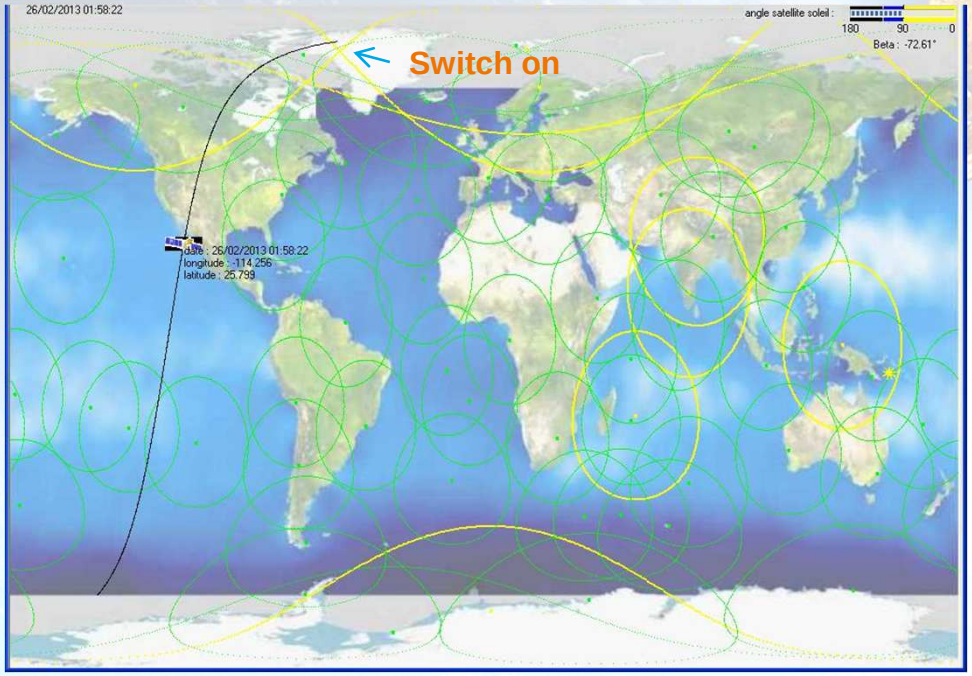
- First Altimeter in Ka-band
- Single frequency Ka-band altimeter with an enhanced bandwidth
  - Reduced ionosphere effects authorizes mono-frequency altimeter
  - 480 MHz bandwidth : better vertical resolution (30 cm) => error budget improvement
  - Ka-band and increased PRF (4 KHz) : improved spatial resolution
  - Antenna footprint : 8 km diameter => less pollution
  - Variable PRF along the orbit
  - Ka-band limitations : sensitivity to atmospheric water content
- Dual-frequency radiometer (23.8 GHz +/- 200 MHz & 37 GHz +/- 500 MHz)
  - Required for wet troposphere correction on altimeter measurements
  - Embedded within the altimeter, shares the DPU and the antenna
  - Radiometer footprint : 8 km in Ka, 12 km in K

SARAL – First in flight AltiKa altimeter measurements
26th of February 2013

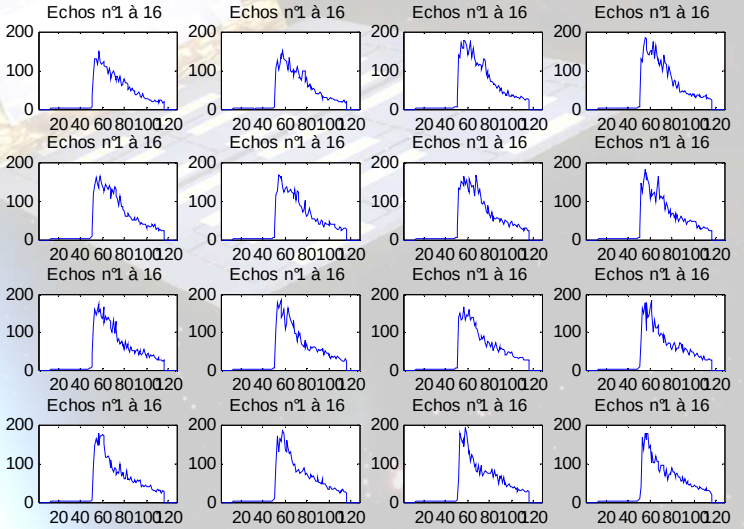
AltiKa switch ON : 01h42min UTC



Position on orbit of the first acquired Altimeter data

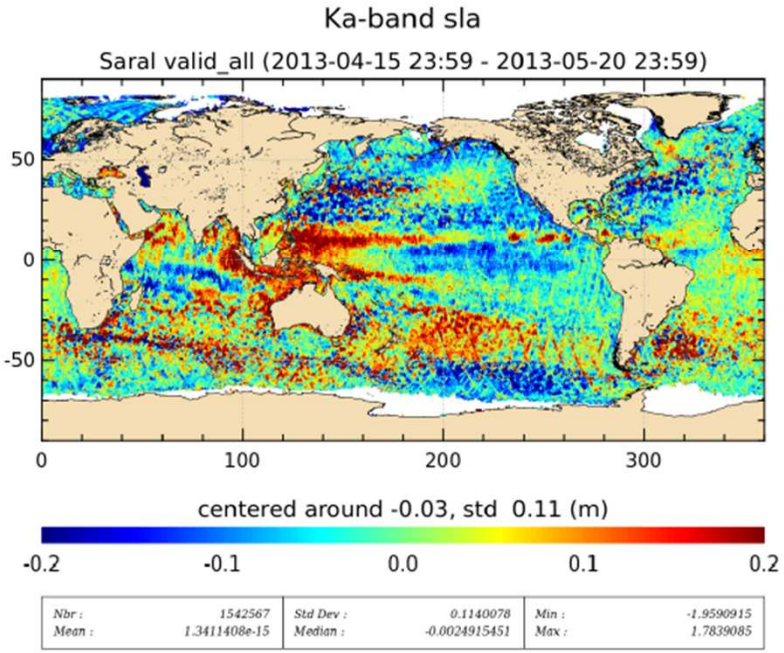


Some waveforms above the sea

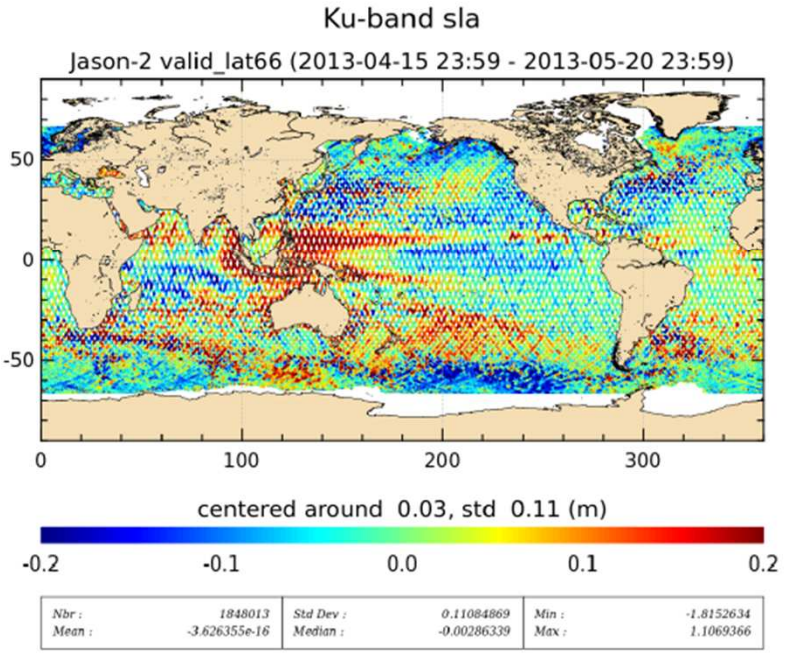


Performances analysis : SLA (Sea Level Anomaly)

Maps of the Sea Level Anomalies are impressive. There is a mean bias of the order of 6 centimeters which needs to be investigated.



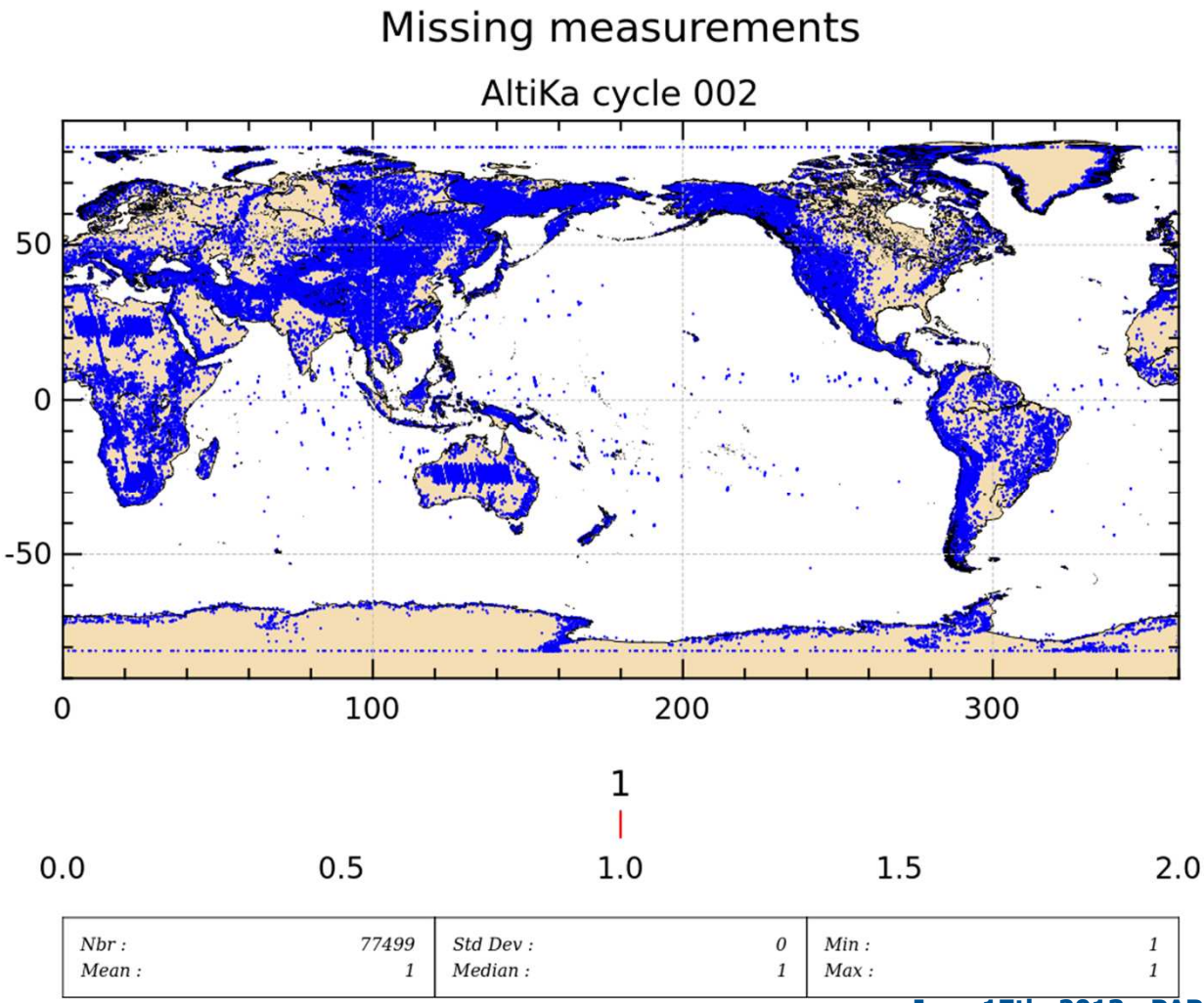
SLA IGDR Altika last 35 days



SLA IGDR JA2 same period

Missing measurements

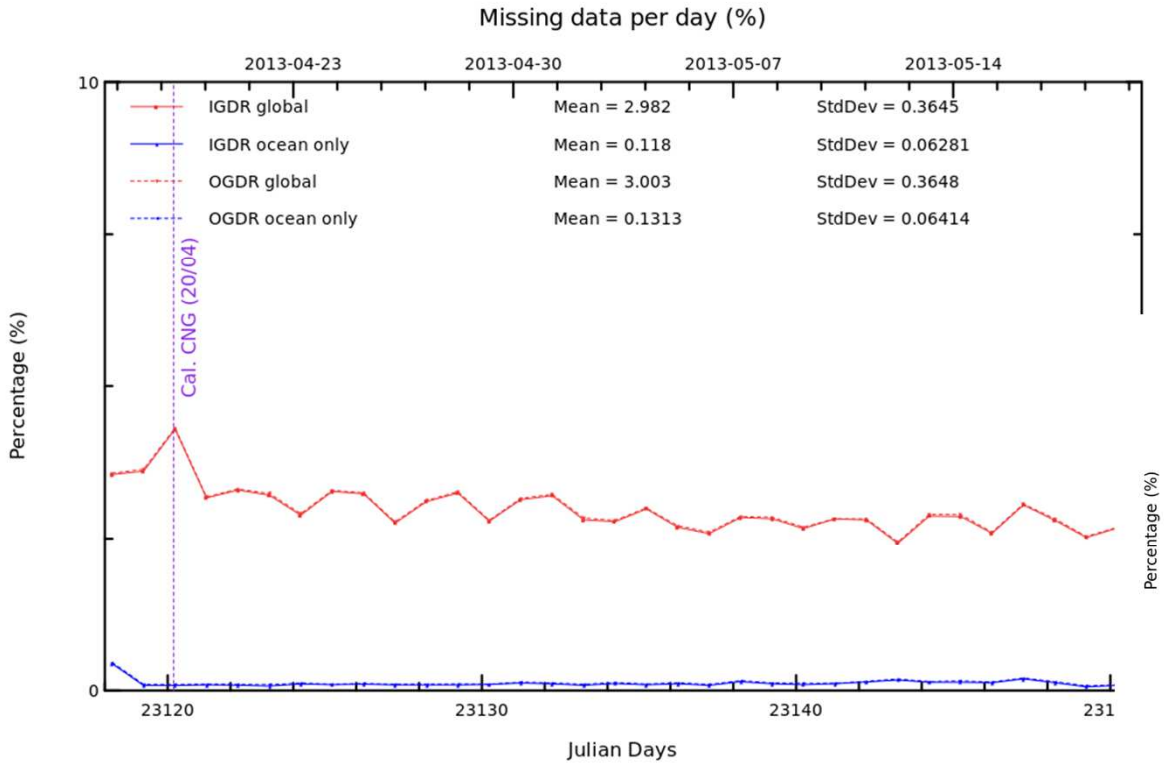
Map below displays the missing measurements over cycle 002. Data return is remarkably high with a very few missing data over ocean.

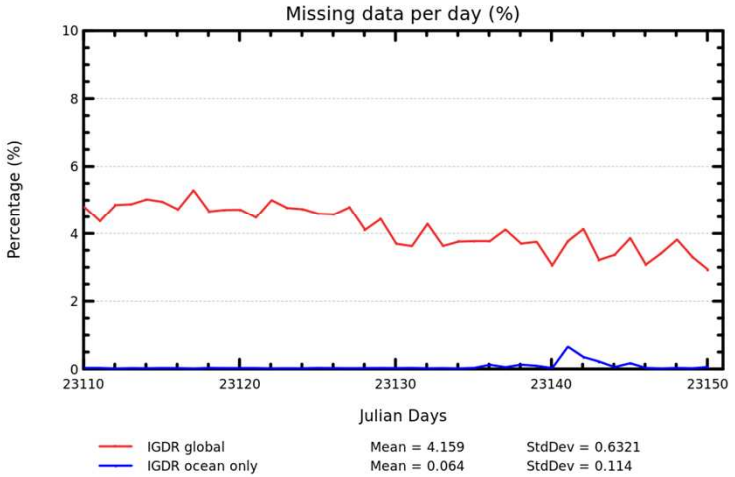


Missing measurements

Daily monitoring over cycle 002 confirms the high data return.

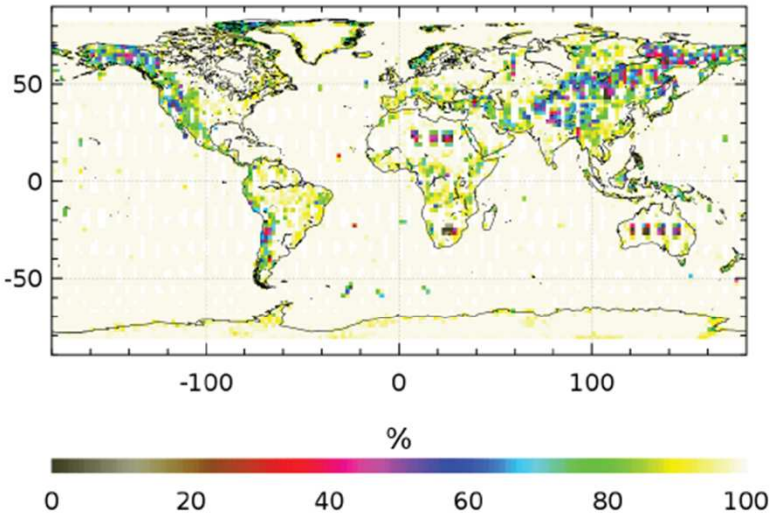
Over ocean surfaces the number of missing data is about 0.1 %, slightly above the Jason-2 figure (0.06 % - knowing that this figure is impacted by the Usingen problems – in routine the Jason-2 figure is about 0.02%).



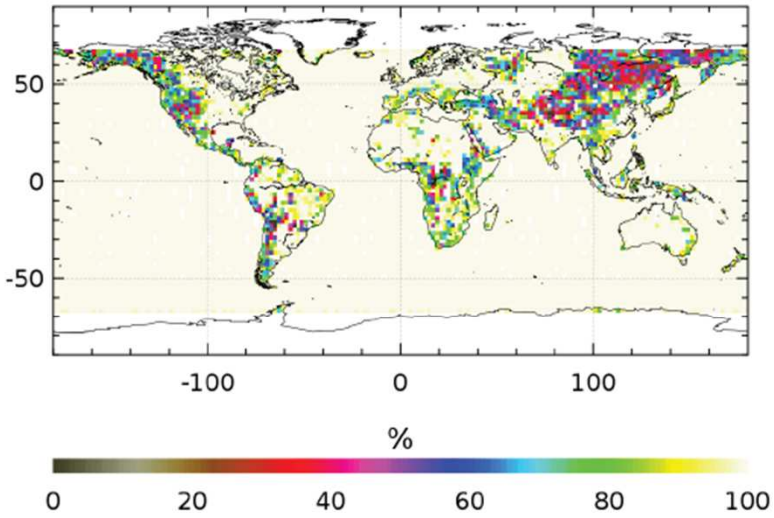


Missing measurements

Over land surfaces the SARAL data return exceeds the one of Jason-2 (3% of missing data for SARAL over all surfaces, 4.1% for JA2)



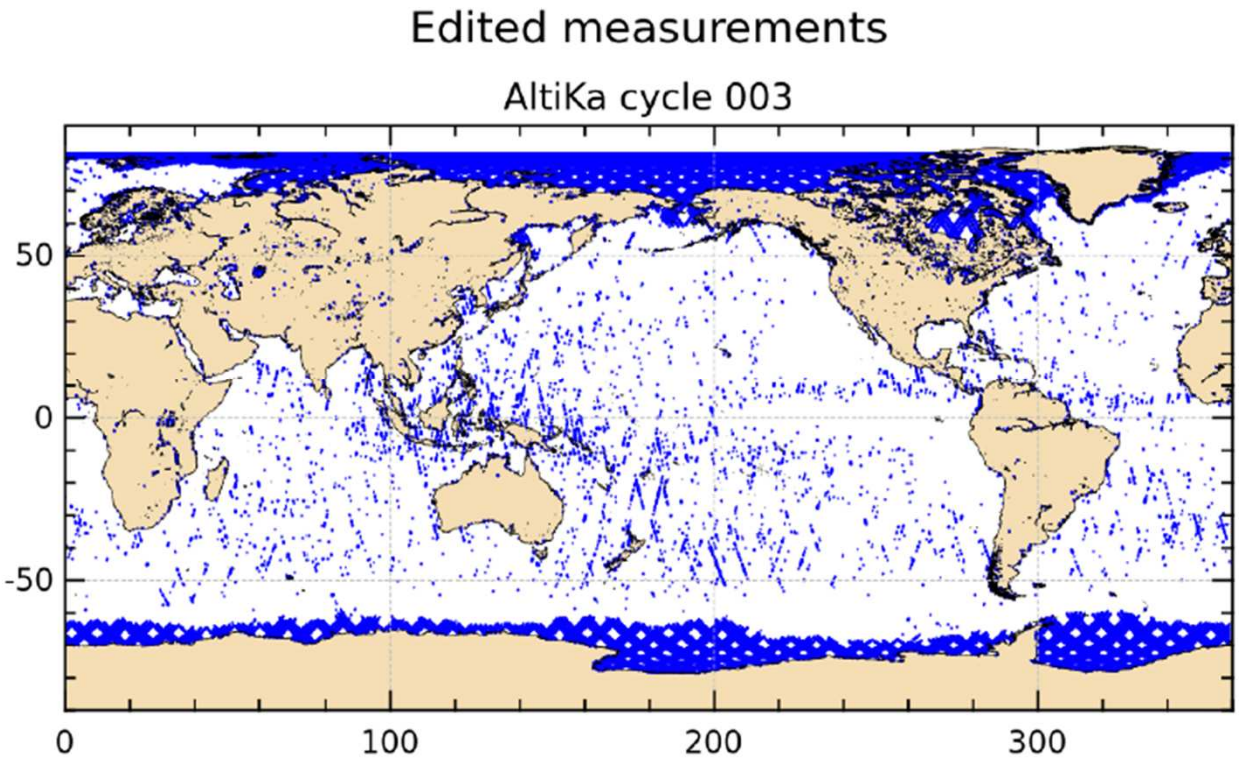
AltiKa



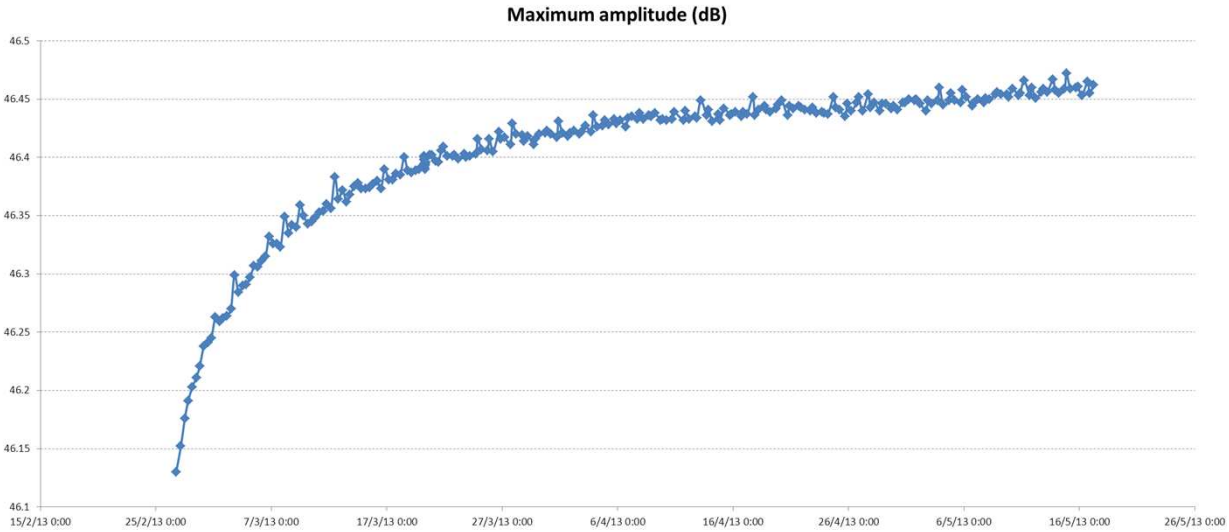
Jason-2

Data editing

Data editing has to be performed in order to remove degraded measurements which may occur in case of rain, sigma0 blooms, … Map below displays the measurements edited over cycle 003 using standard CalVal metrics.

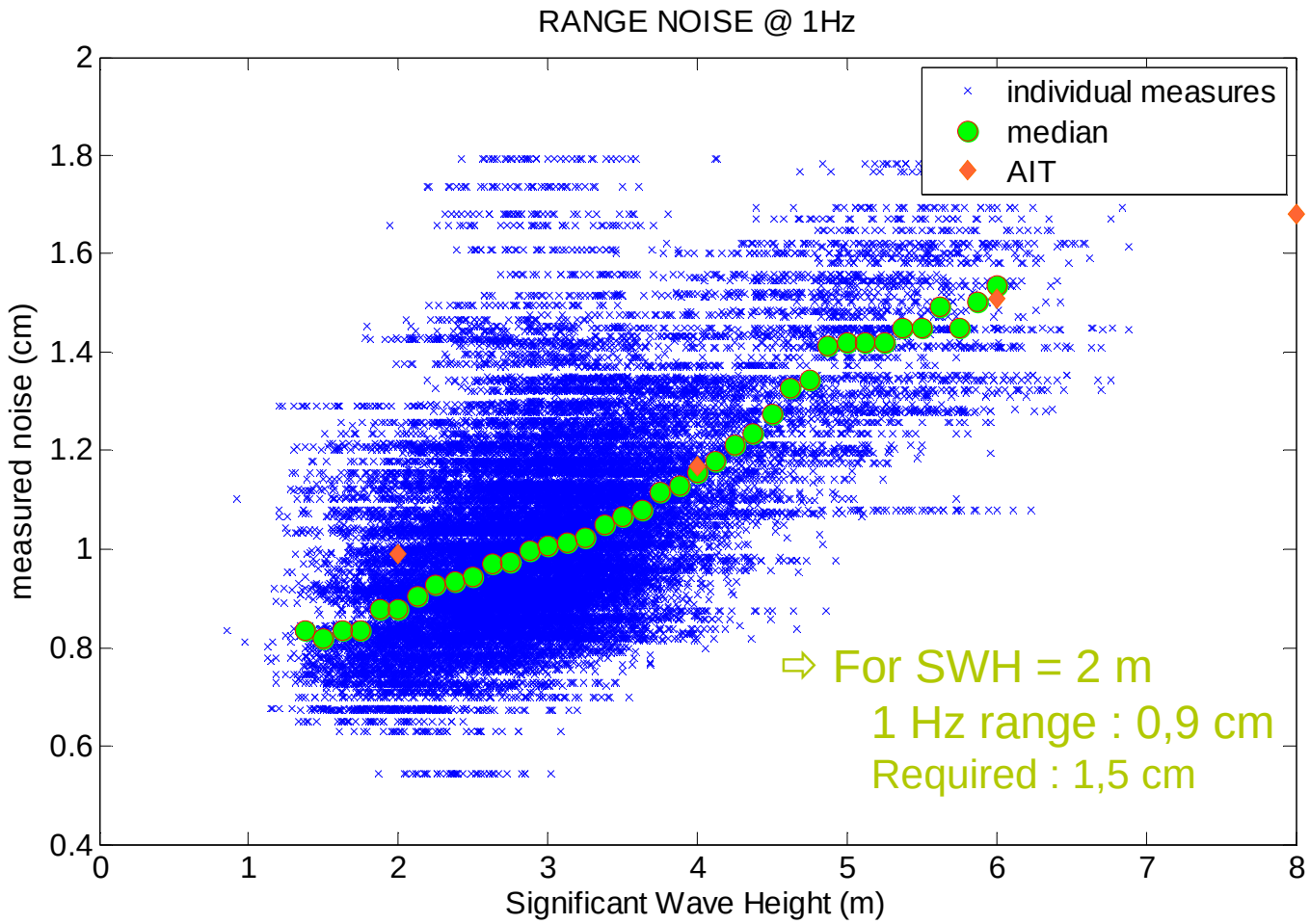


Instrument performances

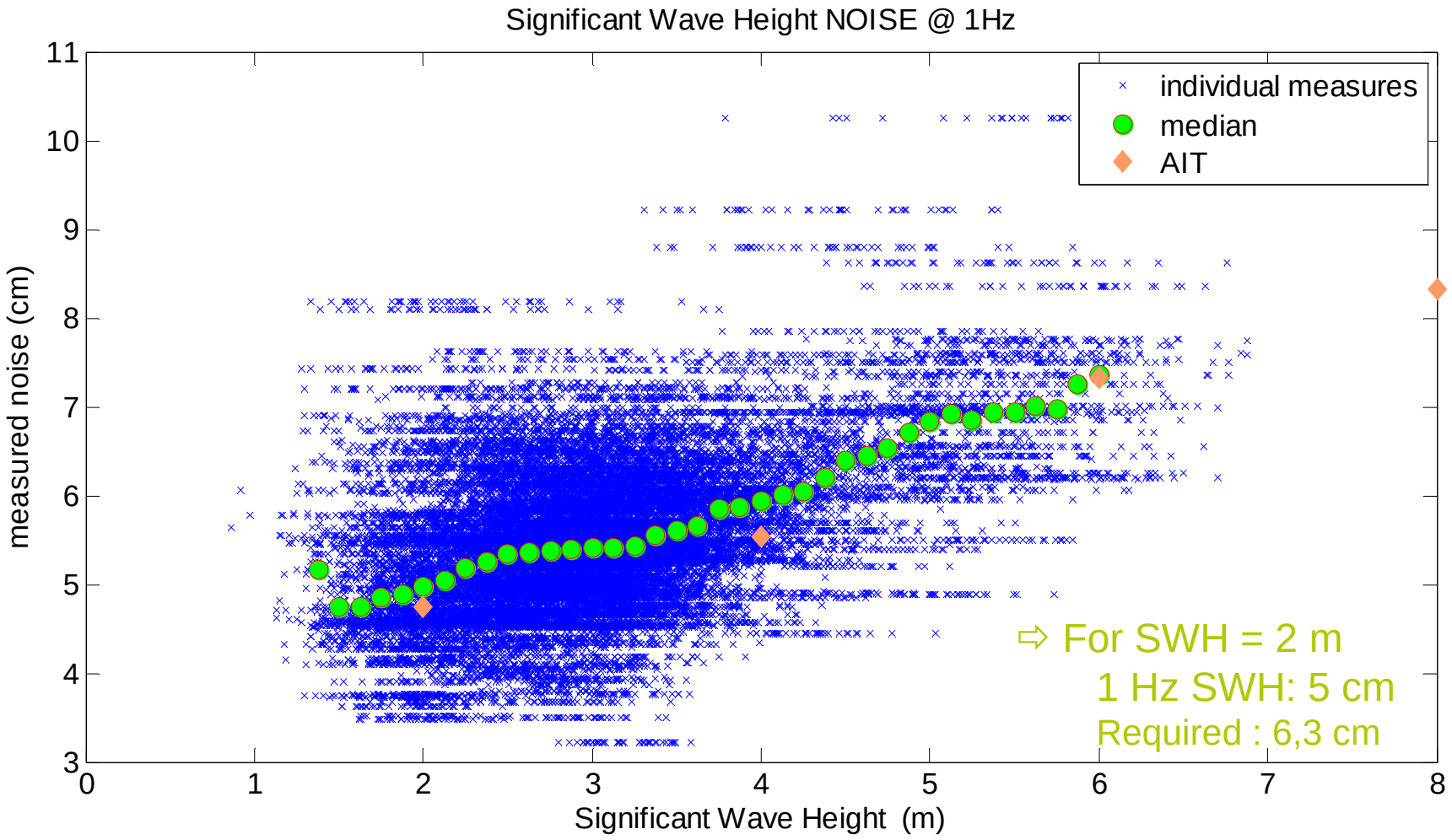


- Altimeter
  - Assessment phase : very good stability of calibrations
  - No thermal dependence
  - Very close to AIT results
  - Gain steps calibration with 0,02 dB stability
  - Tracker mode : Diode acquisition and median tracking proposed as operational mode
- Radiometer
  - Very good stability at instrument level
  - Very high level of accuracy

Altimeter performances



Altimeter performances



Coastal data quality

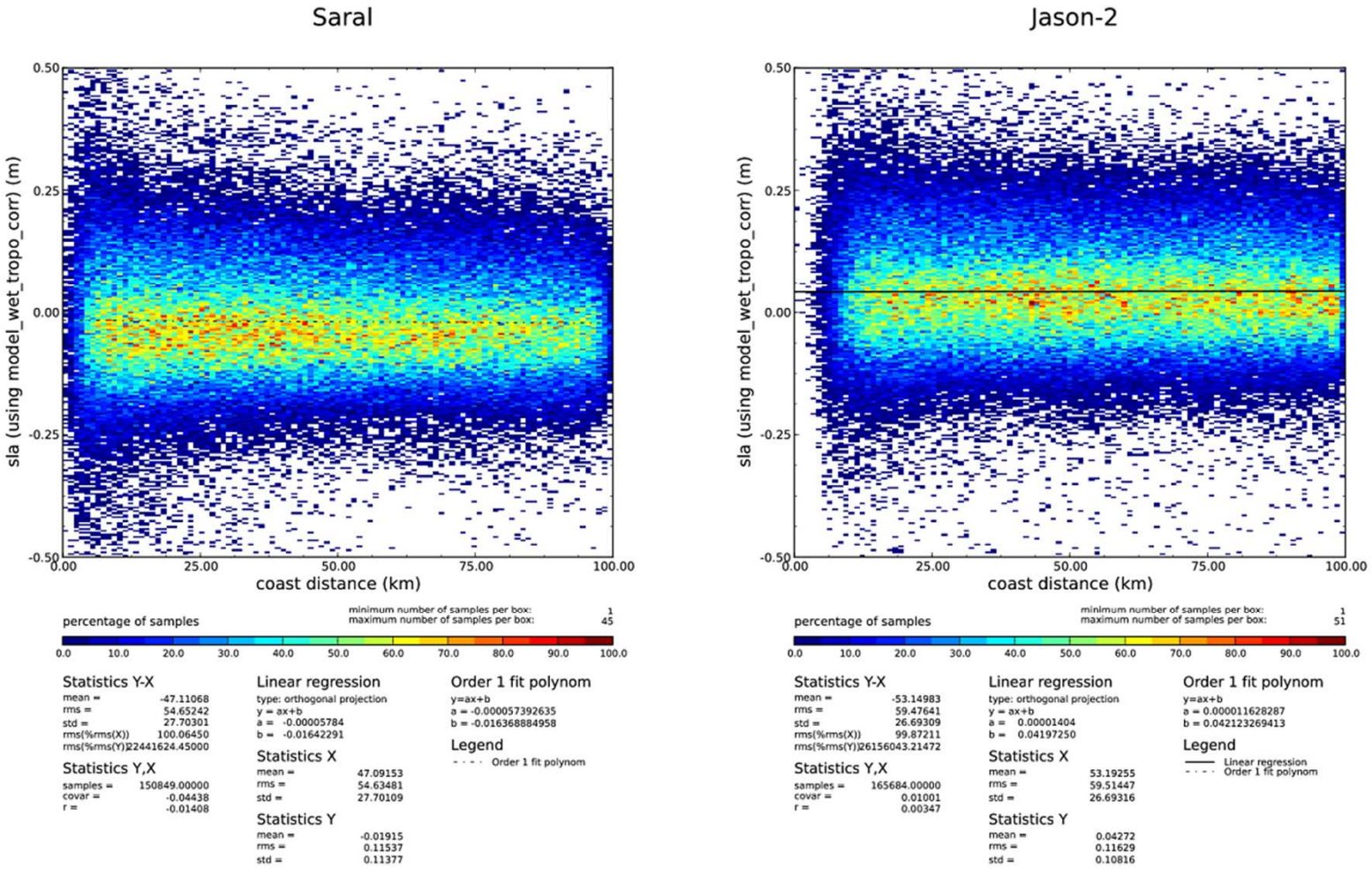
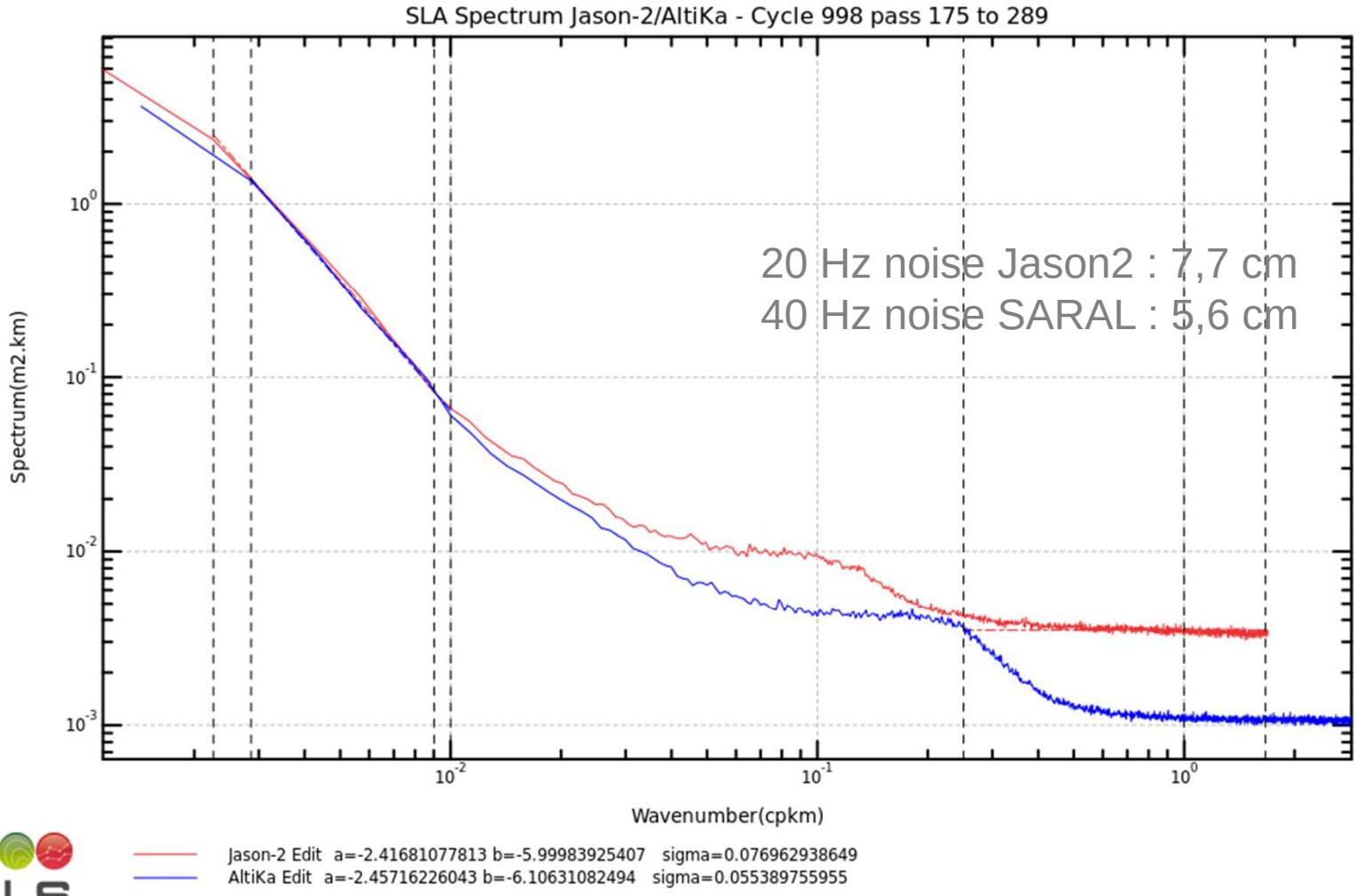


Figure 110: *Scatter Plot for AltiKa (on left) and Jason-2 (on right)*

Performances analysis : Spectrum analysis

The spectrum content is again very good …



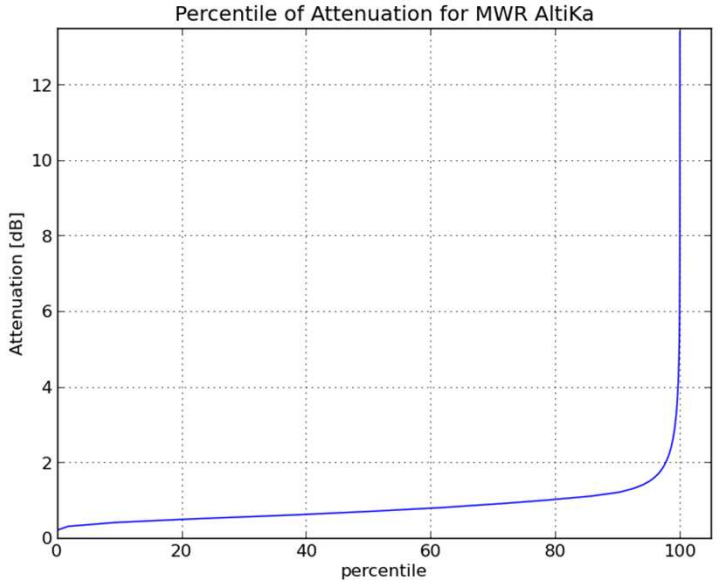
Atmospheric attenuations

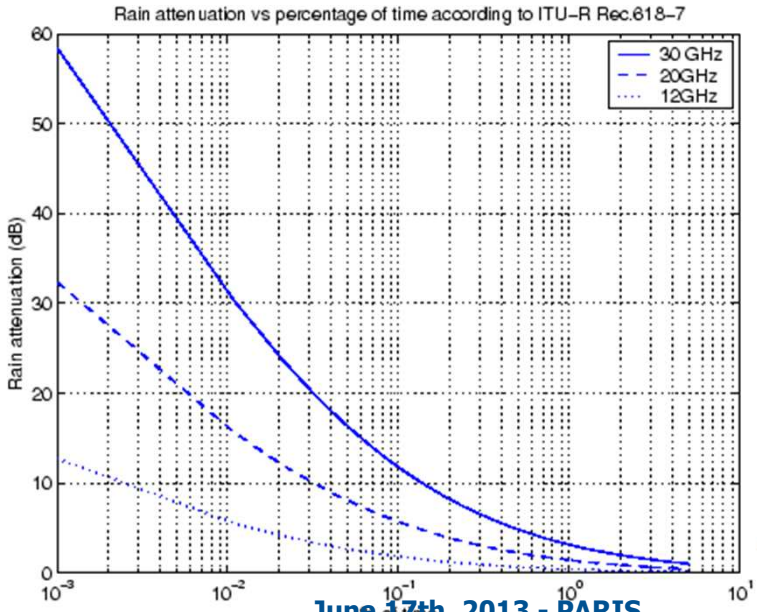
Hypothesis considered during AltiKa development for SNR

- Total attenuation = 3 dB
- Several studies => 3 to 7% of data should be impacted

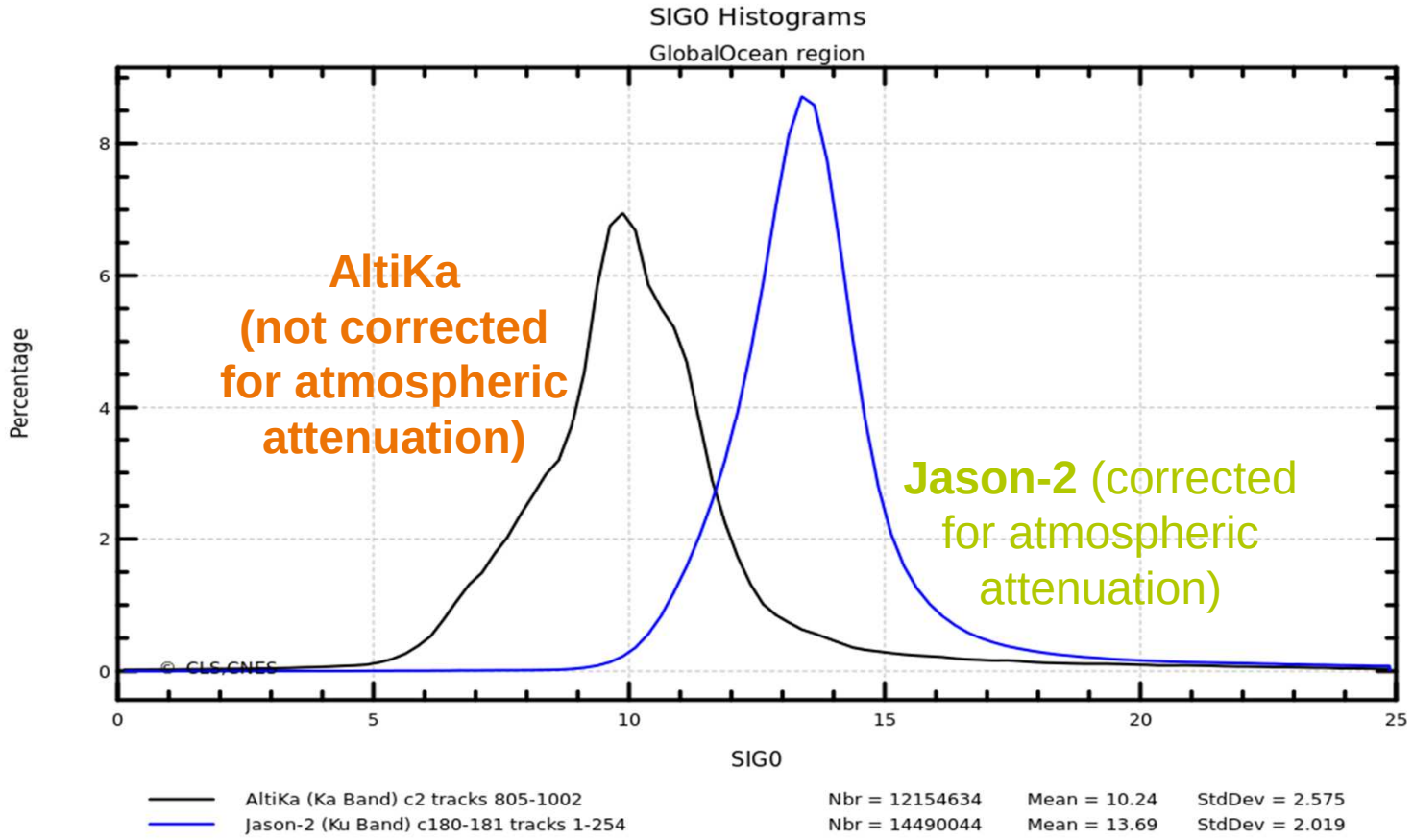
In flight measurements :

- Availablity over oceans : 99,9%
- Preliminary results of attenuation estimated by the radiometer :
  - 1% of attenuations > 3 B
  - 1 ‰ of attenuations > 10 B
  - Coherent with ITU recommendation
- The 3,5 dB margins allocated to mispointing, system margin and ageing provide additional capacity to withstand higher rain rates than targeted





Histograms of SIG0 (Ka/Ku)

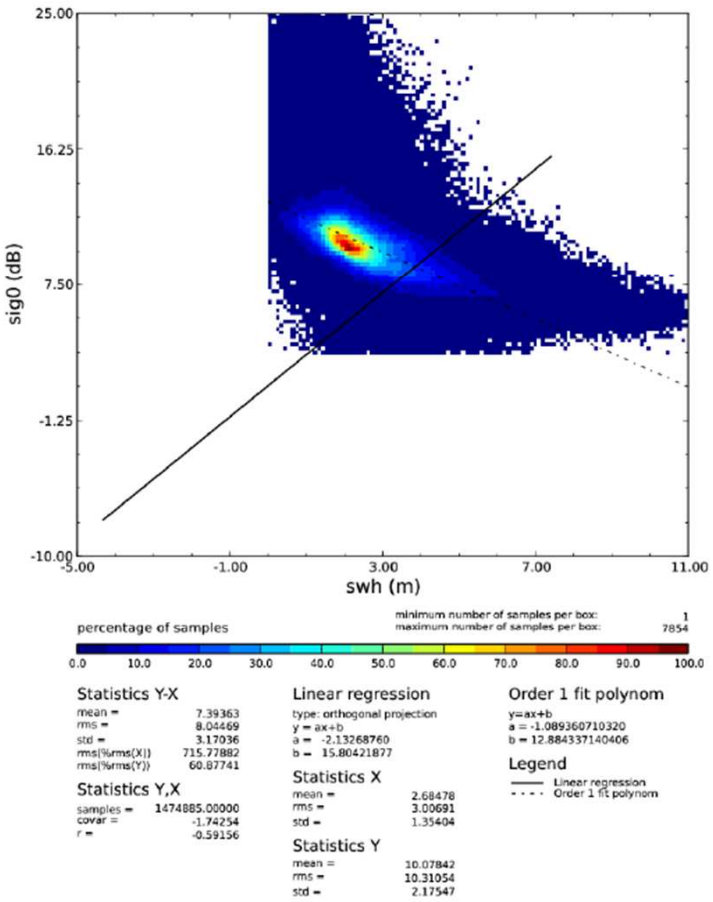


AltiKa 40Hz data : ~200 tracks, 1 cycle
Jason-2 20Hz data : 254 tracks, 2 cycles

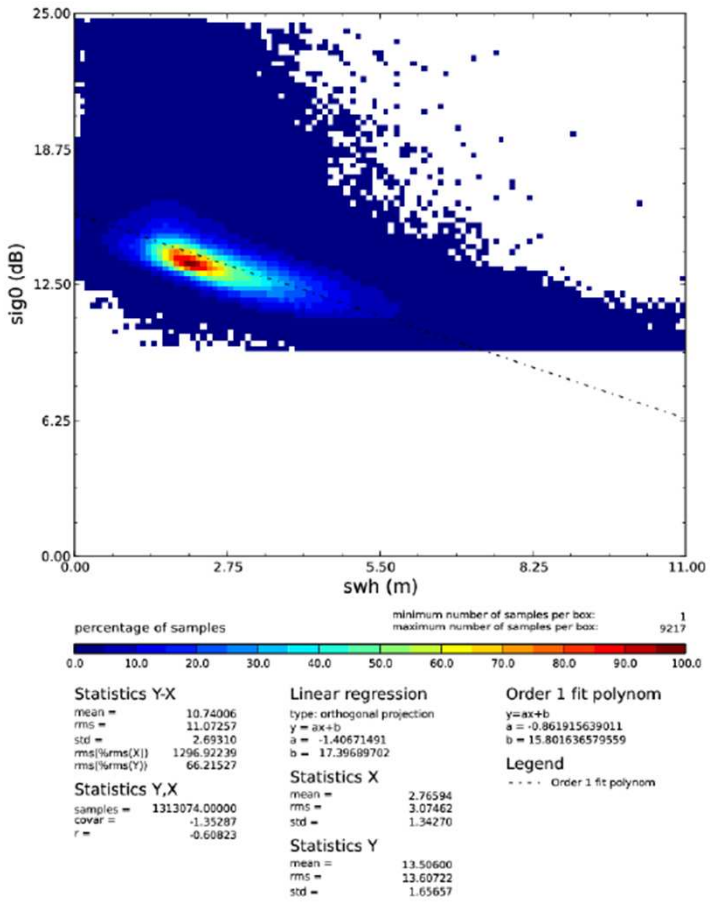
- Wider distribution with a more important low population than in Ku-band
- Average difference around 2,5 dB

Ku/Ka ocean σ0 dispersion wrt SWH

Saral

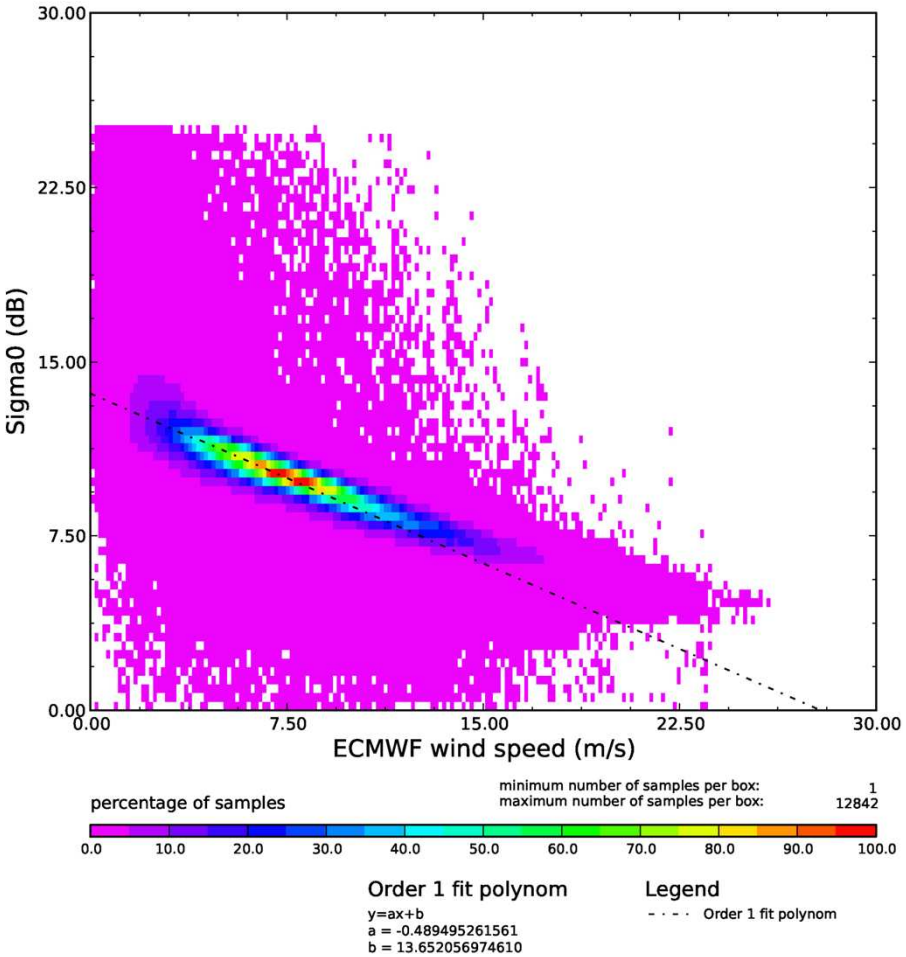


Jason-2

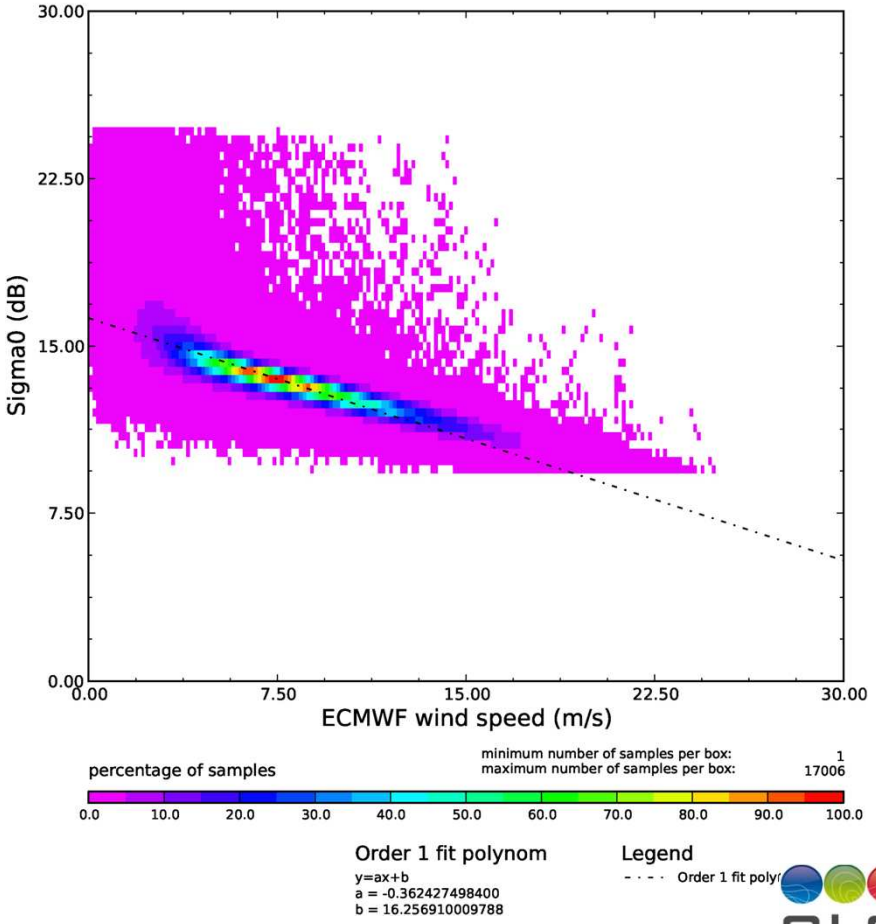


Ku/Ka ocean σ0 dispersion wrt ECMWF WS

AltiKa IGDR



Jason-2 IGDR



Ocean Sigma0

Mean σ0 value observed on ocean = 11 dB (incl. a mean atmospheric attenuation of 0,9 dB)

For mean sea state : SWH=2m, wind speed = 7 m/s

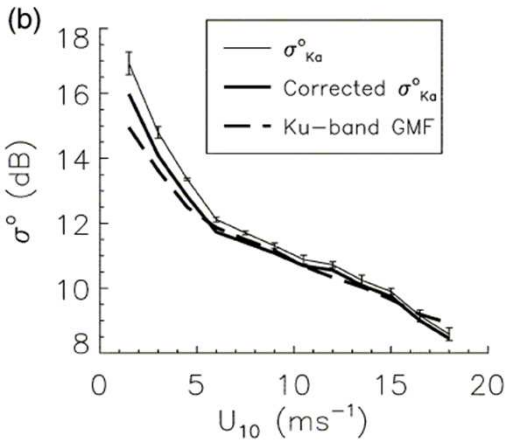
Comparison with Ku-band data : **-2.5 dB w.r.t. Jason mean value**

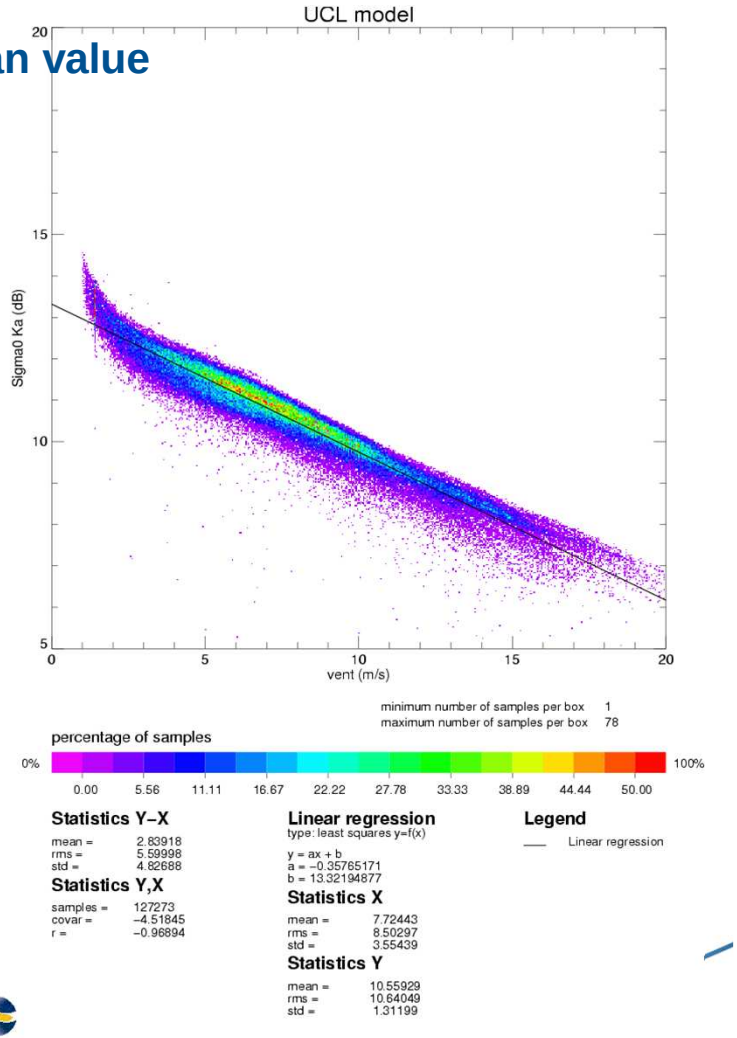
Hypothesis considered during AltiKa development

- σ0 = σ0 Ku [Topex] – 1,5 dB ≈ σ0 Ku [Jason] – 3,5 dB

Based on several studies/results among which

- Vandemark et al, 2004 : For a wind speed > 5 m/s,
  σ0 Ka ≈ σ0 Ku [Topex] ≈ σ0 Ku [Jason] – 2 dB
- UCL model
- AltiKa Busard measurements :
  Nadir σ0 = 11 dB on river, 10 dB over sea surface



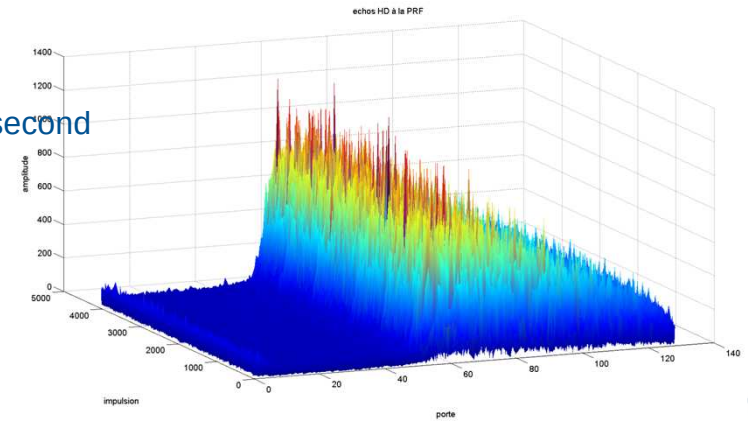


Continental water and surrounds

- Cf. LEGOS team hydro first results (J.F. Crétaux and S. Calmant)
  - AltiKa ensures the continuity of ERS2 and Envisat measurements
  - Measurements over small rivers (< 100 m)
  - Flooded forests : Ka waves penetrate through forests, water level can be measured
  - In lakes and rivers surrounds, with reasonable relief, the altimeter can provide some terrain elevation measurements
    - ⇒ Very promising first results
    - ⇒ σ0 to be analyzed in those areas

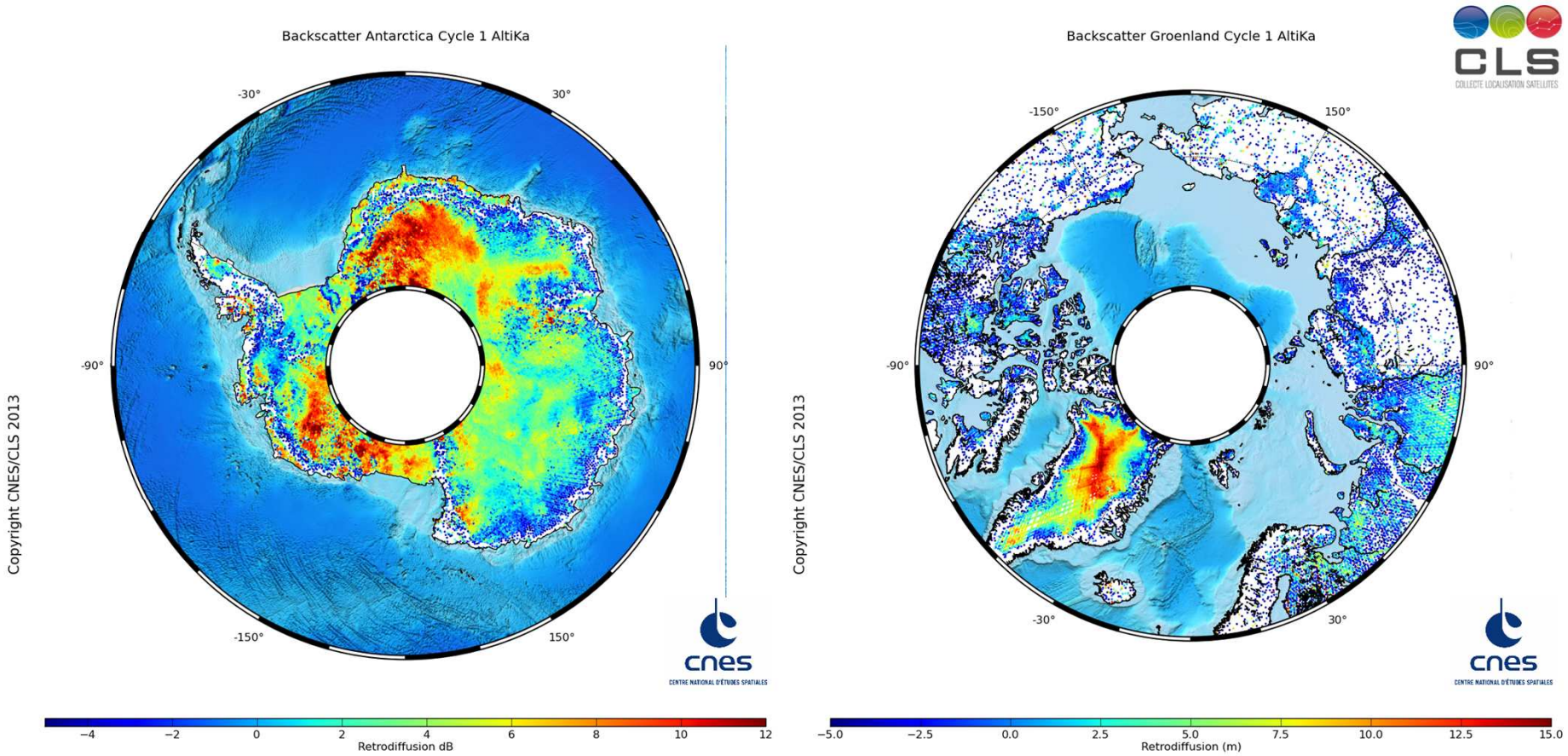
Conclusion and outlook

- AltiKa is working properly and OGDRs and IGDRs data quality are inline with mission requirements
- First CalVal meeting took place in Toulouse June 13th and 14th and demonstrated the very good quality and performance of AltiKa data
- A very few data are lost by loss of tracking due to atmospheric attenuation
- Accuracy of measurements : < 1 cm on range for SWH = 2 m
- AltiKa data are of very high interest for SWOT purpose
  - First analysis demonstrate that Ka band σ0 dependence with surface roughness is higher than in Ku band => theoretical Ka band radar measurement physics to be correlated with AltiKa measurements
  - Behavior and σ0 contrast around continental water areas
    - What retracking to use to extract σ0 ?
    - Use of HD data : allows to record data at the PRF rhythm during 1 second
  - Comparison between Ku and Ka data



Back up slide

Ice sheets σ0



- First studies (LEGOS team, F. Remy and all) demonstrate a very high sensitivity to the terrain characteristics
- Ongoing analysis